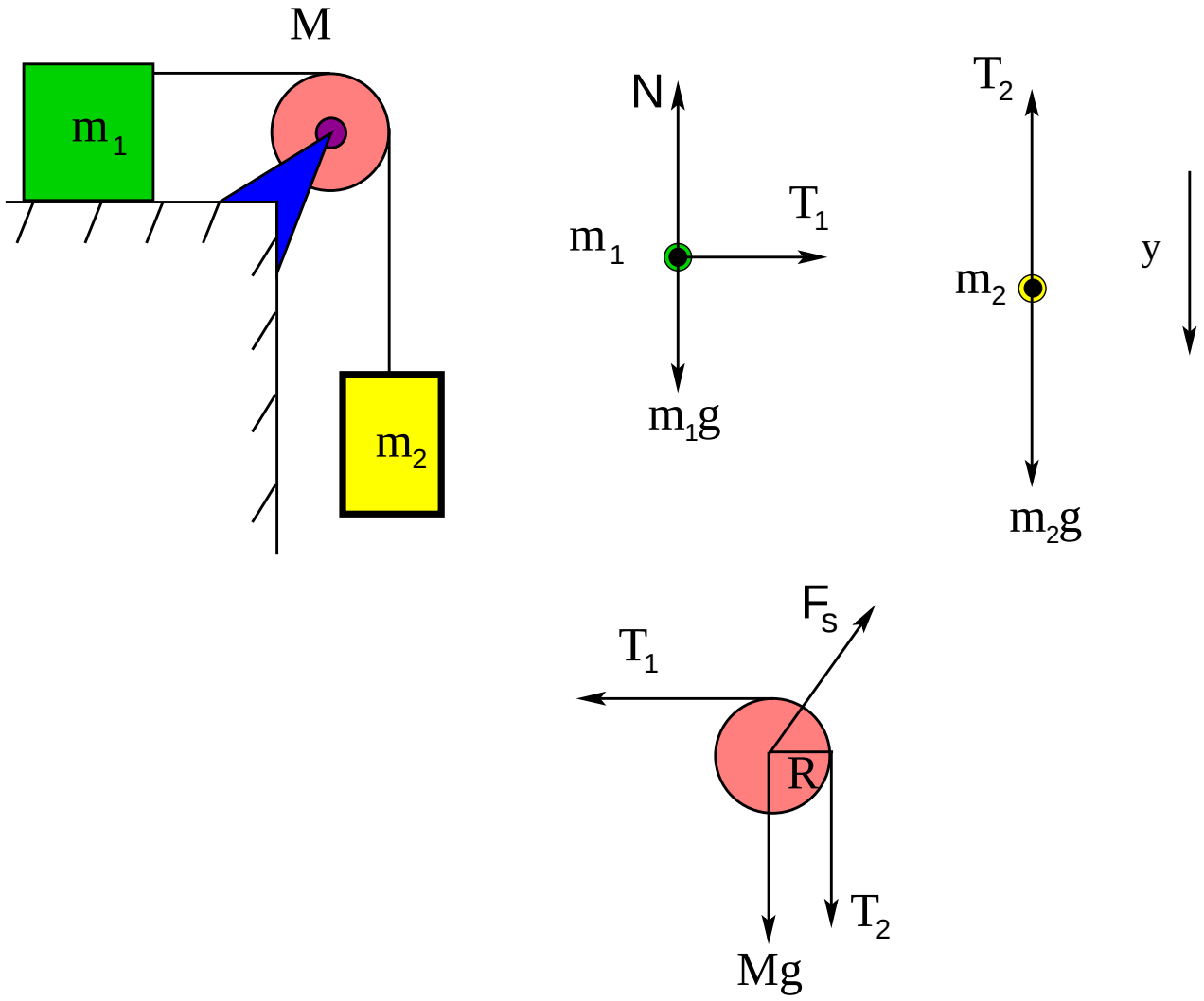
Ex : Two blocks are connected by a string that passes over a pulley of $\mathbf{R = 5\ cm}$ with $\mathbf{I = 0.0025\ kg{\cdot}m^2}$. If m_1 $\mathbf{= 5\ kg}$ and $m_2 = \mathbf{7\ kg}$, the surface is frictionless, and the system is initially at rest, find the acceleration of the system.



This problem **must** begin by drawing free-body diagrams for all of the relevant systems.

Also realize that we will have to employ both the translational and rotational form of Newton's 2^{nd} law.

$$\Sigma F = ma \qquad \Sigma\tau = I\alpha$$

◦ Begin with Newton's 2^{nd} Law for translations:

$$\Sigma F_x = m_1 a = T_1 \qquad (1) \qquad\qquad \Sigma F_y = m_2 a = m_2 g - T_2 \qquad (2)$$

◦ Now use Newton's 2^{nd} Law for rotations:

$$\Sigma\tau = I\alpha = RT_2 - RT_1 = I\alpha = I\frac{a}{R}$$

$$\text{or} \quad T_2 - T_1 = \frac{Ia}{R^2} \qquad (3)$$

Note: T_2 will not equal T_1 in this example or the pulley would not turn!!

We now have 3 equations for 3 unknowns (T_1, T_1, a). Solve for a.

$$a = \frac{m_2 g}{m_1 + m_2 + I/R^2} = \frac{7\ kg \cdot 9.81\ m/s^2}{5\ kg + 7\ kg + (0.0025\ kg{\cdot}m^2/0.05\ m^2)}$$

$$a = 5.28\ m/s^2 \qquad\qquad \left(a_{I=0} = 5.72\ m/s^2\right)$$